

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a system for transferring heat energy generated in a gas turbine engine among a first oil loop for cooling an engine accessory drive, a second oil loop for cooling and lubricating the engine bearings and other internal structures, and the fuel stream supplied to the engine for combustion therein.

It is further an object of the present invention to distribute said heat energy responsive to the current rate of heat generation occurring within the accessory drive, engine, and fuel stream for achieving efficient and reliable operation over the engine power output range.

It is further an object of the present invention to provide a heat transfer system able to cool the fuel stream by one or more oil loops during low power engine operation, and to cool the oil loops with the fuel stream during high power engine operation.

It is still further an object of the present invention to accomplish the distribution of heat energy by directing a bypass flow of fuel among a plurality of return locations in the fuel stream responsive to the desired heat transfer performance.

According to the present invention, heat is transferred between each oil loop and a flowing fuel stream by a pair of fuel-oil heat exchangers receiving the fuel stream in series. The fuel stream passing through the fuel-oil heat exchangers includes at least a portion of the fuel supplied from the aircraft fuel tank by a boost pump at a metered rate equal to that currently being delivered to the gas turbine engine combustor.

The fuel stream enters a main fuel pump operating at a fuel flow rate in excess of the metered rate, hence requiring a portion of the fuel flowing therefrom to be returned to the fuel stream prior to the main fuel pump. This diversion of the main pump outlet flow is accomplished by a fuel controller which determines the metered fuel flow rate responsive to the demanded engine power level.

According to the present invention, a bypass conduit having at least two branches is provided for returning the bypass flow to two or more locations in the stream flowing to the main fuel pump, thus altering the fuel flow rate and effectiveness of one or both of the fuel-oil heat exchangers.

The bypass fuel is allocated among the return locations responsive to the engine power level. Specifically, one embodiment of a system according to the present invention returns the bypass fuel to first and second locations disposed respectively upstream of the first loop fuel-oil heat exchanger and intermediate the first and second loop fuel-oil heat exchangers. Allocation of the bypass fuel flow between the first and second locations is accomplished by a diverter valve manipulated responsive to the engine power level.

A second embodiment according to the present invention returns the bypass fuel flow to first and third locations disposed respectively upstream of the first loop fuel-oil cooler and downstream of the second fuel-oil cooler prior to the main fuel pump. Allocation of the bypass fuel between the first and third locations is accomplished passively by the effect of one or more flow restrictors placed in the bypass return line. It is an additional feature of this second embodiment that the fresh metered fuel entering the system from the boost pump may bypass the fuel-oil heat exchangers at high metered

fuel flow rates reducing the total fuel pressure drop between the boost pump and the main fuel pump.

The present invention thus optimally matches fluid temperatures and heat exchange rates between the fuel supplied to the engine and the oil loops under all engine operating conditions, thereby reducing the requirement for auxiliary oil cooling with compressed engine air or the like. The invention further provides, for those situations wherein the rate of heat buildup in the fuel stream is excessive due to a high bypass flow as compared to the metered flow, a means for cooling the recirculating fuel through a reverse transfer of heat energy from the fuel into the circulating oil loops.

Still another advantage of the allocating function according to the present invention is a reduction in the maximum rate of fuel flowing through an individual fuel-oil heat exchanger relative to the minimum rate, thus reducing exchanger size while providing sufficient heat transfer capacity under all cooling conditions. Both these and other advantages will be apparent to those skilled in the art upon careful inspection of the following description and the appended claims and drawing figures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a flow schematic of a first embodiment of a fuel and oil heat management system according to the present invention.

FIG. 2 shows a flow schematic of a second embodiment of a fuel and oil heat management system according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED AND ALTERNATIVE EMBODIMENTS

FIG. 1 shows a schematic representation of the fuel and oil flow systems for a gas turbine engine 10. An accessory drive 12 is mechanically linked (not shown) to the engine 10 and is cooled by a first oil loop 14 wherein oil flowing from the accessory drive 12 passes in sequence through a first air-oil cooler 18 and a first fuel-oil heat exchanger 20 before being returned to the accessory drive unit 12. Cooling air 22, extracted from the compressor or fan section of the engine 10, passes through the air-oil cooler 18 and is regulated by a first air control valve 24.

Lubricating and cooling oil for the main engine bearings and other internal components circulates in a wholly separate oil loop 16, passing in sequence through a second air-oil cooler 26 and a second fuel-oil heat exchanger 28 before returning to the engine 10. Cooling air 30 for the second air-oil cooler 26 is also extracted from the engine fan or compressor and is regulated by a second air control valve 32.

Combustion fuel is supplied to the engine from the main fuel tank 34 by a fuel system including an engine driven boost pump 36. Boost pumps are typically centrifugal pumps designed to operate at an essentially constant pressure for a given engine speed, independent of the volumetric flow rate of fuel therethrough. Boost pump 36 supplies fuel to a fuel conduit 38 at a flow rate equivalent to the current fuel demand of the gas turbine engine 10. This flow rate, termed the "metered fuel flow rate", is determined by the main engine fuel control 40 as discussed hereinbelow.

The metered fuel flow enters the first fuel oil heat exchanger 20, passing therethrough and flowing subsequently through the second fuel-oil exchanger 28, a fuel